Interim Progress Report Submitted to
NOAA's Human Dimensions of Global Change Research Program

Project Title: Testing the Ability of Subsistence Farmers to Use Seasonal Climate Forecasts: A Participatory Approach in Zimbabwe.

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1 Preliminary Materials

1.1 Project Abstract

Currently at NOAA and other governmental and intergovernmental agencies and research institutes, scientists are working hard to develop and apply seasonal climate forecasts. In large part, these forecasts have been made possible by an ever improving understanding of dynamics between oceans and the atmosphere, such that with data about ocean temperatures (which change relatively slowly over time) one can make predictions about weather patterns in particular places around the world, many months in advance. Ideally, these forecasts would allow decision-makers in all kinds of climate related sectors to plan ahead, and improve their decision-making. Organizations such as the NOAA-funded International Research Institute for Climate Prediction (IRI) are working to make such forecasts useful to a variety of decision-makers. They are paying a great deal of emphasis to users in developing countries, where traditionally people have had little access to high quality scientific information, and where many people's lives are highly vulnerable to climate.

Past research has shown that many potential users of climate forecasts do not use the information as much as scientists had hoped, even though it is likely that using the information would greatly improve their chances for improving their quality of life. This is especially so of small-scale farmers in developing countries. One of the first countries where scientists attempted to make climate forecasts both widely available and user-friendly was Zimbabwe. Nevertheless, during the last major El Niño episode—1997-98—it appeared that few small-scale farmers used the information. There are several different hypotheses about why this is so: farmers do not learn about the forecasts; farmers do not understand the forecasts, especially forecasts that are probabilistic; farmers do not trust the forecasts, especially after past forecasts have proven less than accurate; farmers do not trust the people telling them the forecasts; the forecasts come at the wrong time to be useful to the farmers for their actual decisions; the forecasts give farmers the wrong kind of information; the forecasts are not accurate enough to be useful; the forecasts do not include reference to local and traditional indicators with which farmers are familiar; or, there are no practical decisions that farmers could make differently because of the forecasts. To best improve future forecast development and communication practices, it would be valuable to learn which of these hypotheses is in fact an obstacle to successfully using the forecasts. The goal of this research is to test these various hypotheses.

Figure 1: Two sisters evaluating their maize field during a mid-season dry spell.

In order to test any hypothesis about a cause-effect relationship between two variables, it is necessary to analyze multiple observations in which there exists variance in the independent variable. This fundamental need guides the research methodology for this project. First, we deliberately introduce variance into the system we are studying in a way that does not make any members of that system—farmers in Zimbabwe—worse off. We do this by trying to "improve" one or more of the independent variables, primarily be taking the time to explain the forecasts in a much better way than has heretofore occurred. This takes place in a village "forecast workshop" that lasts one entire day, and which a number of farmers from the community attend. We repeat these workshops on an annual basis, in a number of villages throughout the country. These workshops typically occur in September, after the official forecast has been released but before the planting season has begun. Second, we measure the resulting variance in our variables

through a household survey instrument. This takes place in April, at the end of the growing season. These two activities—conducting workshops and administering and analyzing surveys—are the primary activities of this research. We discuss these two activities in the remainder of this progress report. We also discuss other work areas within the project: writing, participation in meetings, and additional research.

Figure 2: Map of Zimbabwe. Workshop locations are in the Eastern Highlands, near Chimanimani, and in the western lowlands, north and south of Bulawayo. Source: CIA

1.2 Objective of Research Project

There are both theoretical and applied objectives of this project. The theoretical objectives are within the disciplines of behavioral economics and geography, and relate to the use of information. What individual factors promote the effective and timely use of new information for problem solving? What institutional factors overcome the individual barriers? How can

information content be structured so as to promote effective use of the information? These questions relate not just to the use of climate forecasts, but really all types of information related to decision-making under conditions of uncertainty, by both individuals and policy-makers. The second objective is related to the field of climate forecast communication, and that is to document the obstacles to forecast use by subsistence farmers, and to test the hypothesis that these obstacles can be overcome through strategic communication practices.

1.3 Approach

The main approach has been experimental. The central piece of work in the project is a controlled experiment occurring over three years. Our control group is farmers who receive forecasts through the standard channels, such as the radio. Our treatment group is farmers who attend workshops, where they learn more information about the forecasts, of a different character. By then observing how these two groups react to the forecast, we can tell whether the particular methods used in the workshops made a significant difference. In the process of surveying all farmers, both in the control and treatment groups, we can gain additional insights into their decision routines, and how forecasts fit into those routines.

Figure 3: Agricultural extension worker Ndondana Dube (left) with teachers at the Mafa Primary School, during a workshop.

In terms of specific theory tested, that derives from the behavioral economic literature, in terms of barriers to effective decision-making arising out of the misapplication of engrained decision-heuristics. We are unconvinced that that farmers are making bad decisions, and yet we are also confident that there are places where their decisions could be improved, once one understand how the procedure of decision-making influences their choices.

1.4 Description of matching funds

Social Science Research Council, Program in Applied Economics. 2003 Risk and Development Field Research Grant ($2,600). This has supported the research assistant, Pablo Suarez, to conduct additional fieldwork in Zimbabwe, as well as complementary fieldwork in Argentina, necessary for his PhD dissertation.

ProVention Consortium, 2003 Applied Research Grant for Disaster Risk Reduction ($3,900). This has allowed Pablo Suarez to attend workshops on disaster risk reduction and management in Austria and Japan.

2 Interactions

2.1 With decision makers

Since the purpose of the project is to test the use of information by decision-makers, we have had extensive interactions, beginning with the farmers themselves.

Subsistence farmers: Each year we held one workshop in each of the four locations in Zimbabwe (Mhakwe, Tiya, Mkoka-Matopos and Mafa). Between forty and sixty farmers participated in each workshop (more than 200 farmers per year in total). In addition to the workshops participants, this field project has impacted a large number of farmers in the area where the events were held by way of informal communication among farmers.

Figure 4: Workshop participant describing performance of prior year's crops.

Zimbabwe Agricultural Extension Service (AREX): Interactions included feedback regarding workshop format and logistics, revision of survey instrument, assistance in guiding dialogue on response strategies during participatory workshops, as well as detailed explanation of seasonal

forecast. Contacts included the AREX coordinator for the Chimanimani District, Mr. Mughani, and the following field officers: Ms. Olinda Tuso (Biriwiri Village), Ms. Loice Mubako (Bumba Village), Mr. Limon Ncube (Lupane District) and Mr. Dube Ndodana (Ken Maur Village).

Figure 5: Agricultural extension worker Olinda Tuso (in red) and teachers at the Tiya Primary school, before a workshop.

Local elected officials and traditional leaders: Assistance in inviting farmers to workshops and arranging logistics, key role in workshop discussions regarding responses to forecast. Mr Watchy Sibanda (Ward councilor, Mkoka-Matopos) and Mr. Mukazhi (Ward Councilor, Mhakwe). Chief Moyo (Mkoka-Matopos) invited half a dozen of his colleagues from several communities in Matabeleland to the workshop.

Schoolteachers: Workshops were held in schools most of the time, and benefited from the valuable participation of teachers and schoolmasters. Mr. Mukwambo and Mr. Gwavuya (Tiya), Mr. Kaneta, Mr. Mandzidzidze and Ms. Majeje (Mhakwe), Ms. Bhebhe and Mr Sibanda (Mkoka-Matopos), Mr Sibanda, Mr Kudakwashe and Ms Dube (Mafa). In addition, we assisted each of the schools in establishing a rainfall monitoring program (rain gauge and log book) for their students to oversee.

University of Zimbabwe: Our local collaborator, Ms. Chiedza Gwata, teaches at the University's Department of Agricultural Economics. Many of her graduate students, who will be expected to move into the field of agricultural extension, have participated in the project as enumerators or as assistants in the decision-making experiments.

2.2 With climate forecasting community

The project has led to sustained communication with members of the forecasting community in order to learn about forecasts and climatic conditions in Zimbabwe, to share results and lessons learned from participatory workshops, and to seek feedback regarding publication manuscripts.

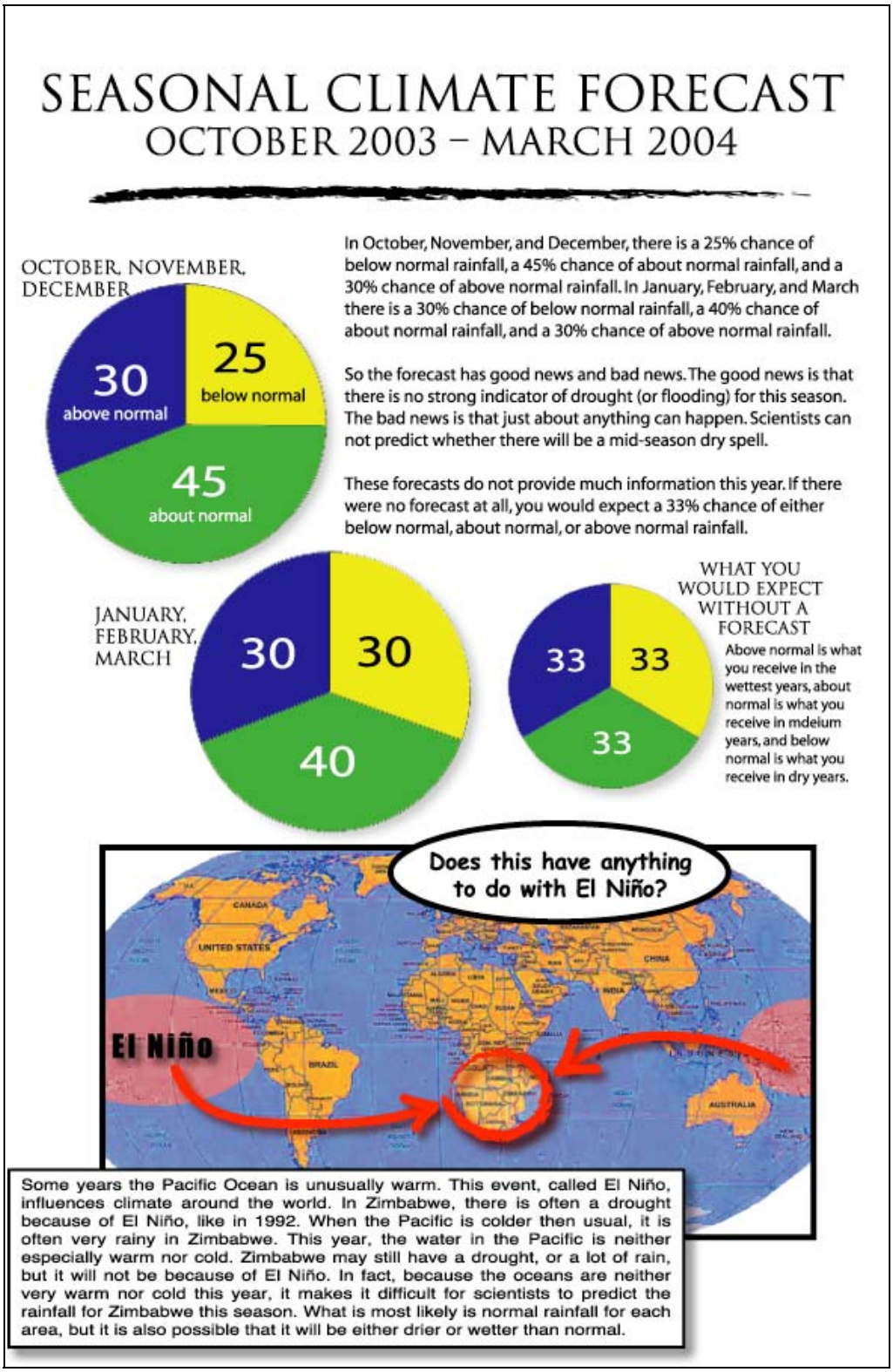

Figure 6: Climate forecast poster distributed at workshops.

Southern Africa Regional Outlook Forum (SARCOF): We have actively participated in the meetings in Harare (2002) and Lusaka (2003), interacting with forecasters from Southern Africa, the US and Europe, as well as local forecast users from different sectors. The interactions took the form of presentations (two per event), active engagement in discussions, and in the case of the Lusaka event, joint work with media representatives to "adapt" the SARCOF statement to a language more suitable for mass media.

Drought Monitoring Centre for Southern Africa: We have had extensive discussions with Emmanuel Dlamini, of the Harare DMC office, concerning the products of the SARCOF meetings, as well as methods and tools for climate forecasting. Mr. Dlamini also participated in an expert survey we conducted, at the UNFCCC Ninth Conference of the Parties (Milan, Italy), on the communication of uncertainty related to climate prediction.

International Research Institute for Climate Prediction (IRI): Interacted via email and in person with researchers at IRI, particularly Maxx Dilley, James Hansen, Simon Mason.

2.3 Coordination with other NOAA projects and researchers

With Emma Archer, in South Africa, we have worked at developing a common survey instrument,that would allow comparisons of our findings. This involved a site visit to her location in the Limpopo Province of South Africa, as well as discussions with her in Zimbabwe and in Cape Town.

We have reviewed proposed work by James Hansen and Guillermo Podestá and have had several NOAA researchers review our proposed work and findings (Jennifer Phillips, Guillermo Podestá, Corrinne Valdavia). We have had discussions with Paul Kirschen and Carla Roncoli about the design of their methodology in Burkina Faso, in order to improve our own methodology.In compiling literature, we have kept in close contact with these other NOAA researchers.

We have had discussions with Maxx Dilley concerning the organization of the September 2004 SARCOF meeting. We plan on attending the meeting, and in working with him and others at the Harare DMC to assist in organizing the meeting.

With Colin Polsky, we have organized a panel session at the Open Meeting of the Human Dimensions of Global Environmental Change Research Community (Montreal, October 2003), examining adaptive capacity and the role of climate information in the improvement of adaptive capacity. Also at the Open Meeting in Montreal, we have participated in the panel session organized by Nancy Beller-Simms and Caitlin Simpson on the use of climate forecasts for decision making.

3 Accomplishments

3.1 Research Tasks Completed

Up to date, the accomplishments of the project could be broadly grouped in the following categories: forecast communication, surveys, decision-making experiments, and theoretical work.

3.1.1 Forecast communication

Since the beginning of the project we have conducted participatory workshops in four communities in rural Zimbabwe each year. While the main purpose of these workshops was to communicate the scientific forecast for the coming season and to explicitly test the benefits of providing more, rather than less, information, we structured these events in a way that tried to show respect for traditional forms of knowledge, and to facilitate the exploration of response strategies on the part of subsistence farmers. These workshops occur as soon as possible after the September SARCOF meeting, typically the third or fourth week of September. This is sufficiently far in advance of the planting season—usually mid-October through December—to allow farmers to use the information gleaned in the forecasting workshops to purchase different farming inputs, especially different varieties of seeds. While we organize and facilitate the workshop, we also count on the local agricultural extension officer, as well as local leaders—schoolteachers, village chiefs, village elders—to participate actively and share their knowledge. Between forty and sixty farmers—a mix of men and women—attend each workshop. The workshops last most of a day, and give participants an opportunity to learn and ask questions about not only the official scientific forecast, but also background information (such as what El Niño actually is), sources of uncertainties in the forecast, and how the forecast compares with the village leaders' interpretation of local and traditional indicators.

Figure 7: Chiedza Gwata and Pablo Suarez at a workshop

The structure of these participatory exercise typically includes (a) a review of the previous season and how different crops performed, (b) an exchange of ideas about what their traditional indicators suggest for the coming season, (c) comprehensive information about El Niño and why it may change the climate in remote places, (d) communication of the scientific seasonal climate forecast (farmers are given the opportunity to ask questions about it), and (e) a dialogue in which farmers and local leaders develop response strategies to the combined message of traditional indicators and the scientific forecast. As facilitators, we do not make specific recommendations for how the participants can use the information, but do encourage them to think actively and collectively about possible response strategies. We have valuable information, collected during

the workshops themselves, which can help understand the role of climatic information in decision making. In addition, we have a video record of all workshops, and are assembling an instructional video with this footage.

Figure 8: Flooding in Buenos Aires shantytown

With complementary funding from other sources, a similar approach to participatory communication of scientific information was implemented in Argentina. This fieldwork two workshops in two flood-prone shantytowns the Buenos Aires Metropolitan Area, which are likely to experience more frequent and severe flooding as a result of climate change. The approach was slightly different: rather than focusing on climate predictions as the core of the workshops, these events were structured around the issue of vulnerability and vulnerability reduction. Climate change forecasts were introduced mainly as a trigger for community-based strategies to increase resilience to extreme events.

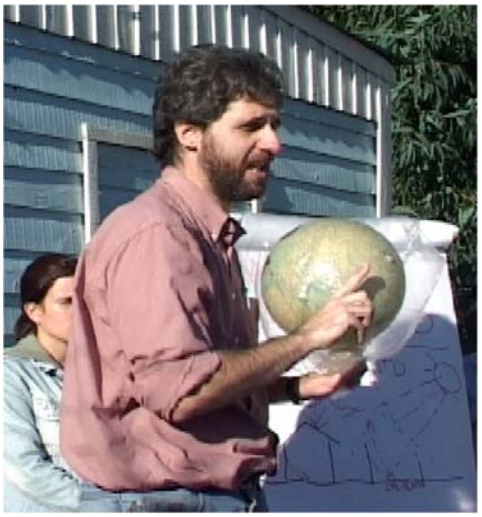

Figure 9: Pablo Suarez conducting workshop on relationship between climate change, climate variability, and flooding.

3.1.2 Household survey

At the end of the rainy season (usually April), a survey is conducted in each community to evaluate the impact of the forecast on decision making, both on farmers who attended the workshop and farmers who didn't. Approximately three hundred farmers are surveyed each year.

The survey is thirteen-pages long, and is designed to gather data on such issues as demographics, assets, perceptions of risk, farming practices, access to and understandability of climate forecasts, and responses to the forecast (both desired and actually implemented). Graduate students from the University of Zimbabwe assist as enumerators and in data entry. Fieldwork for the surveys takes three days in each of the four villages, with enumerators walking from household to household to interview respondents personally. The local collaborator, Chiedza Gwata, has primary responsibility for supervising the enumeration, with assistance from Bulawayo resident Alan Eson. We, in turn, work with them to make sure that the survey is capturing a representative sample, and in continually refining the survey for clarity and precision.

3.1.3 Decision Making Experiments

As behavioral economists, we are particularly interested in potential cognitive and behavioral obstacles to the rational use of climatic information. In other words, it is possible that farmers (and forecasters) will be subject to biases that result in sub-optimal results at the individual or collective level. In particular, we are interested in examining how three behavioral factors influence the uptake and use of climate information: present-biased discounting, status quo bias, and heuristics of trust generation.

Figure 10: Participant (in hat) laying one of the decision-making games, with two University of Zimbabwe students administering it.

To examine each of these issues, we engage in the standard behavioral economic practice of conducting decision-making experiments. These are often games that participants play, in which they make a series of decisions under highly structured incentive structures, such as small cash prizes. We conducted experiments both in the cities of Harare and Bulawayo, and in the four village fieldsites, during the September 2003 trip. Additionally, Pablo Suarez conducted experiments in the Argentine shanty towns in early 2004. We had a total of over 500 participants playing three different types of games. The initial design of the games were developed in coordination with David Cash and Hannah Bowles at Harvard University.

3.1.4 Theoretical Model Development

This research has led to theoretical explorations, including the specification of conceptual models to describe the use of information for decision-making. These include: approaches to forecast communication (ways to increase the likelihood of farmers listening to, understanding and making use of the forecast); role of climate predictions in decision making (factors that facilitate or constrain the use of climate prediction); and behavioral economics and climate forecasts (how different heuristics and biases may influence how predictions are used).

3.2 Summary of Preliminary Findings

Over the first half of the research period, several preliminary findings shed some light on our understanding of the process of forecast communication.

3.2.1 Importance of the participatory approach

Many commentators have discussed the problems of unidirectional initiatives to disseminate climate forecast and have called for a participatory approach to the communication of seasonal climate predictions. This study is finding solid evidence that indeed subsistence farmers are much more likely to understand and use climatic information if it is presented to them in a format that allows them to feel fully engaged in the process, from asking questions about the basic science of El Niño to discussing at the community level what are the best seed varieties given the new information.

The figure below shows the proportion of Zimbabwean farmers that, when surveyed in April 2003, expressed that (a) they found the forecast useful, and (b) they could point to specific different decisions they made based on the forecast. The positive impact of the participatory workshops is evidenced by the fact that, of those who attended the workshops almost eighty percent found the forecasts useful (and about sixty-five percent actually made different decisions), compared to around thirty percent in the case of those who didn't participate but heard of the forecasts through different channels. Within this latter group, almost all heard the forecast over the radio, with a small percentage hearing it from agricultural extension workers. It should also be noticed that this participatory approach has the potential to multiply the dissemination by way of word of mouth: about one fourth of those who didn't attend the workshops did hear about them, and they were more likely to find the forecast useful (and make use of it) compared to those who neither attended nor heard.

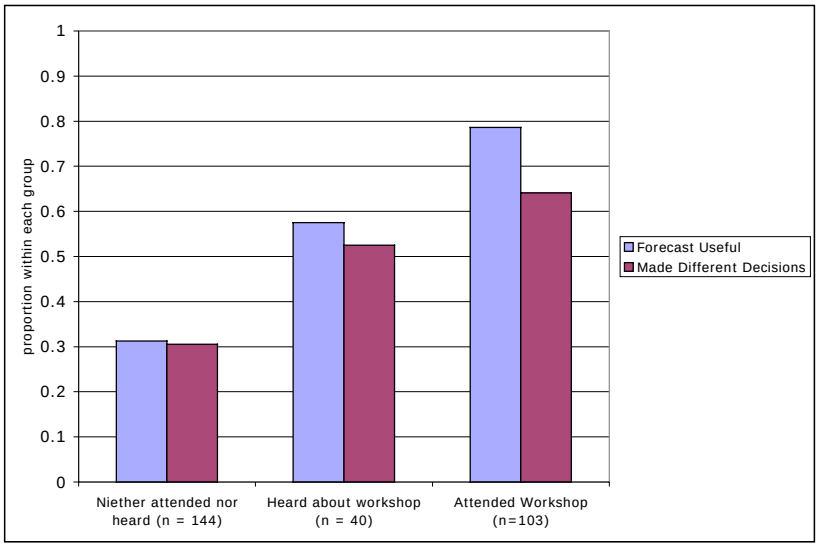

Figure 11: Differential us of forecast among those learning of it.

We are finding that, with a participatory framework to forecast communication, farmers are

- *More likely to make different decisions based on their interpretation of the forecast.* However, at least not until their confidence in the information grows overall, they are not likely to make decisions that could be overly costly, should the forecast have turned out to be "wrong". Some people had purchased a little bit extra of one kind of seed or another in response to the forecast, or modify distance between rows and other farming practices, but nobody had had gone so far as to take big risks such as change varieties on an entire field. This should come as no surprise: It may be very wise for farmers to be cautious in putting the forecasts to use. It may, for example, be hard to evaluate of the rainfall would have been sufficient for the normal crops if one made the decision to plant them at all.

- *Less likely to misinterpret information.* The questions that people asked typically revealed an understanding of the information. For example, after a discussion of the El Niño phenomena in the Pacific Ocean, people asked such questions as: "What causes the water temperature to be warmer one year, and then colder the next?", "What impacts does El Niño have on the weather in South America, where it is closest?", and "Can El Niño have an impact on cyclones, the ones that come from the Indian Ocean to Zimbabwe?" We suggest that these questions at least reveal that people are paying attention, understanding the concept of probabilistic drivers of weather.

- *More likely to continue to trust scientific information after a poor forecast.* Despite the oft-repeated saying that trust is hard to win and easy to lose, we find that farmers' trust in scientists appears to fall slowly. In our opinion, what destroys trust is not so much being wrong, as being dishonest. As long as forecasters do their best to transmit all of the information they know—and crucially the uncertainty associated with what they know—farmers are likely to 'forgive them' if the weather does not turn out exactly as forecasted. This resembles the trust they have in their local indicators; at all workshop locations, the participants said that they trusted the indicators, even though they realized that often the indicators were wrong, having witnessed them be incorrect in the past

3.2.2 Role of heuristics and biases in decision making

We have made three sets of findings concerning behavioral factors influencing forecast communication. The first relates to the communicators of the information, the second to the users of the information, and the third to the relationships between the two groups

In terms of the communicators, we have observed extreme caution on the part of forecasters (observed at the SARCOF meeting) in communicating results. Our analysis of the information provided showed that the decision may have erred on the side of communicating too little, rather than too much, information. Where does this caution come from? We examined the hypothesis that omission bias could be at fault, and found this to be the case. Omission bias exists when people are prefer errors of omission (failing to do something positive) instead of committing errors of commission (doing something with negative consequences), even when the consequences of the error of omission are larger. We found particular institutional structures that encouraged this bias.

In terms of the users, we found a high degree of status quo bias, and some degree of present biased discounting related to level of assets and income. Status quo bias occurs when people prefer the current option to new alternatives, even when the expected outcome is higher and the risk lower for the new alternatives. In our case, we observed this among farmer with respect to the varieties of crops they choose to plant. It reveals an additional barrier to the use of new information. In terms of discounting, one experiment we conducted involved farmers making tradeoffs between receiving immediate reward (in the form of cooking supplies), or a greater reward to occur in the future. We observed both the effect of time delay, and the difference in short term versus long term discount rates, to be negatively correlated with farmers' assets.

In terms of the relationship between the communicators and the users, we found that the known incentives faced by the communicators had a large effect on the users' trust of the information. Based on a decision-making experiment, we observed that advice was far more likely to be received and used when the users were aware that the communicators had a financial incentive to provide accurate information, or where a formal relationship existed between communicator and user. These results confirm much of the qualitative results observed for boundary organizations. Additionally, we found that the gender of the both communicator and user to play an important role. Women are both more trusting and more trusted than men.

3.3 Papers and Presentations

3.3.1 Papers

Patt, Anthony and Suraje Dessai (in review). Describing and communicating climate change uncertainty: potential biases and empirical findings. In review at *Geosciences*.

Grothmann, Torsten and Anthony Patt (in review). Adaptive capacity and human cognition: the process of individual adaptation to climate change. In review at *Global Environmental Change*.

Patt, Anthony, David Cash, and Hannah Bowles (in review). Explicitly aligned incentives increase the credibility of expert advisors. In review at *Journal of Risk and Uncertainty*.

Cash, David, Jonathan Borck, and Anthony Patt (in revision). Institutions for linking research to decisions: a comparative analysis of ENSO forecasting systems. In revision at *Science, Technology, and Human Values*.

Patt, Anthony (in press). Trust, respect, patience, and sea surface temperatures: useful climate forecasting in Zimbabwe In R. Mitchell, W. Clark, D. Cash, and F. Alcock (eds.), Global environmental assessments: information, institutions, and influence. Cambridge: MIT Press.

Schröter, Dagmar, Colin Polsky, and Anthony Patt (in press). Assessing vulnerabilities to the effects of global change: an eight step approach. In press at *Mitigation and Adaptation Strategies for Global Change*.

Suarez, P. and Patt, A. (2004). Cognition, caution and credibility: The risks of climate forecast application. *Risk, Decision and Policy* 9:75-89.

Patt, Anthony and Daniel Schrag (2003). Using specific language to describe risk and probability. *Climatic Change* 61: 17-30.

Patt, Anthony and Chiedza Gwata (2002). Effective seasonal climate forecast applications: examining constraints for subsistence farmers in Zimbabwe. *Global Environmental Change* 12: 185-195.

3.3.2 Presentations

"Communicating probabilities with words: potential pitfalls and biases." Intergovernmental Panel on Climate Change Workshop on Describing Scientific Uncertainty in Climate Change to Support Analysis of Risk and Options, Maynooth, Ireland, May 2004. Experts' meeting to support cross cutting theme on uncertainty in the IPCC Fourth Assessment Report. (A. Patt)

"Economic Analysis in Vulnerability Assessment" (Presentation in German) University of Potsdam Seminar Series on Vulnerability Assessment, Potsdam, Germany, May 2004. Invited speaker in seminar series. (A. Patt)

"Horror im Treibhaus: Was sucht der Klimawandel auf der Kino-Leinwand?" (Horror in the greenhouse: what's climate change doing on the silver screen?) Süd-West-Radio Forum (South West Germany Public Radio Forum), Mainz, Germany, May 2004. Invited talk show panelist on the theme concerning the treatment of climate change impacts in the Hollywood film "The Day After Tomorrow." (A. Patt)

"Climate Predictions to Reduce Vulnerability? Lessons from Argentina, Zimbabwe and Behavioral Economics". Social Science Research Council – Risk and Development Fellows' Conference. Airlie Center, Virginia, May 2004. (P. Suarez)

"Community-Based Vulnerability Reduction: Using Climate Information to Trigger Participatory Adaptive Processes". International Research Institute for Climate Prediction (IRI), Columbia University. April 2004. Palisades NY. (P. Suarez)

"Trust me: the effect of economic incentives on advisors' credibility." Potsdam Institute for Climate Impact Research EVA Seminar Series, Potsdam, Germany, November 2003. (A. Patt)

"Trusting Information." and panel chair: "Adaptive Capacity: Toward a Useful Theory." 2003 Open Meeting of the Human Dimensions of Global Environmental Change Research Community, Montréal, October 2003. (A. Patt)

"Evolution of the Climate Outlook Forum Process." Harvard University Center for International Development, Cambridge, October 2003. (A. Patt)

"Climate forecasts, scientific information, and subsistence farming" and "Interpreting Tercile Forecasts" Seventh Southern African Regional Climate Outlook Forum, Lusaka, Zambia, September 2003. Session rapporteur. (A. Patt)

"Getting Our Climate News on the News: Lessons from the Media". Seventh Southern Africa Regional Climate Outlook Forum (SARCOF 7). September 1-4, 2003. Lusaka, Zambia. (P. Suarez)

"How Can Our Science Address Their Exclusion Problems? Climate Info, Economics and Vulnerability". 53rd Pugwash Conference: Advancing Human Security - The Role of Technology and Politics. July 15-17, 2003. Halifax, Canada. (P. Suarez)

"Climate Information as a Neoclassical Approach to Risk? Addressing the Root Causes of Vulnerability". (with Jesse Ribot). Third Annual DPRI-IIASA Meeting: Integrated Disaster Risk Management - Coping with Regional Vulnerability. July 3-5, 2003. Kyoto, Japan. (P. Suarez)

"El Niño, Simbabwe, und die Nutzung von Klimavorhersagen im Entscheidungsprozess unter Bauern. (El Niño, Zimbabwe, and the use of climate forecasts in the decision processes among farmers)" Lange Nacht der Wissenschaften, Jahr der Wissenschaft (Long Night of Science) Potsdam 2003, Potsdam, Germany, June 2003. (A. Patt)

"Building relationships of trust in forecast communication: lessons from Zimbabwe." Association of American Geographers, 2003 Annual Meeting, New Orleans, March 2003. (A. Patt)

"Present-biased behavior, resource use, and agent-based modeling." Swiss Federal Institute for Environmental Science and Technology, Zürich, Switzerland, February 2003. (A. Patt)

"Too Much Caution? Forecast Communication in Zimbabwe." Berlin Conference on the Human Dimensions of Global Environmental Change, Berlin, December 2002. (A. Patt)

"Errors of Omission and Commission: The Risks of Climate Forecast Application". 45th Annual Meeting of the African Studies Association: Africa in the Information and Technology Age. Washington DC, December 5-8, 2002. (P. Suarez)

"Agent-based modeling of adaptive capacity." K.E.R.N. Project Research Group, Christian Albrech Universität, Kiel, Germany, November 2002. (A. Patt)

"Adapting to Climate Change in an Imperfect World." National Oceanic and Atmospheric Administration Office of Global Programs, Silver Spring, Maryland, USA, October 2002. (A. Patt)

"Adapting to Inter-annual Climate Variability." National Institute for Public Health and the Environment, Bilthoven, The Netherlands, September 2002. (A. Patt)

"Seasonal Forecasts, Agriculture and Food Security: A Users' Perspective". Sixth Southern Africa Regional Climate Outlook Forum (SARCOF 6). Harare, Zimbabwe, September 4-6, 2002. (P. Suarez)

3.4 Deviations from proposed work plan:

During the second year of the project there two deviations from the proposed work plan. During the first field trip to Zimbabwe, in September 2003, both Anthony Patt and Pablo Suarez traveled to Zimbabwe in order to conduct the fieldwork. Most of Mr. Suarez' expenses were covered by his other grant funds. Additionally, during that trip, both Patt and Suarez attended the SARCOF meeting in Lusaka, Zambia, immediately prior to conducting the fieldwork in Zimbabwe. This was done in order to have greater inroads into the climate forecasting community, and in order to present preliminary results of the project at the SARCOF. This involved a greater than anticipated additional expense.

The second deviation occurred in May of 2004, during the conduct of the household survey. In the proposed work plan, Anthony Patt was supposed to travel to Zimbabwe to supervise the conduct of the survey. During the first year of the project, the local collaborator, Chirdza Gwata, had demonstrated complete competence in supervising the survey enumeration. Thus, in May 2004, the project saved money by having Dr. Patt, with the assisitance of Pablo Suarez, supervise Ms. Gwata via frequent telephone conferencing and emailing, instead of traveling to Zimbabwe. This allowed Ms. Gwata to spread the survey over a longer period of time (four weeks, instead of two), and saved the airfare costs for Mr. Patt, which went into the hiring of additional survey enumerators.

4 Relevance to the field of human-environment interactions

4.1 How results further understanding the use of forecasts in decision making

The main preliminary result that is useful is the observation that subsistence farmers will actually use climate forecasts, repeatedly, in a manner that is consistent with the information content of that information. Numerous other studies have shown some instances of subsistence farmers using information, but other cases where they failed to use the information, for a variety of reasons. Many of these reasons were related to the communication of the information by the national meteorological staff, often in terms not understandable to poorly educated users. We show that if one overcomes these communication barriers, people do appear to be likely to use the information. We overcame the barrier in a short workshop, which we envision could be implemented on a much wider scale. Hence, we see significant gains to communicating the forecasts well.

Another finding that is interesting relates to the loss of trust after an "unsuccessful" forecast. Many researchers have noted, in Zimbabwe, Brazil, and other countries, that farmers were exceedingly unlikely to use information after an episode in which they had perceived the information as being wrong. This was the case even when the information, probabilistic in nature, was not technically in error, but simply slightly misleading. We found that when the communication practices are improved, including a better description of the limitations of the information, trust is sustained even following a year in which events did not match those predicted as most likely to occur. This, then, has significant implications for the sustained use of forecasts over time. It should be possible to communicate the forecasts year after year, and even

when they do poorly to expect people to trust them in following years, and to continue to base decisions upon them.

The final finding relates to the degree to which cognitive and behavioral factors may limit forecast use, to an extent that one could describe as "non-rational." That is, even if the forecast contains information that people could use to improve their lives, they may choose not to use the information because of the ways in which they make decisions, such as "satisficing" instead of optimizing. That being the case, it requires much greater attention to the ways in which people make decisions, something that can only be reveled in a participatory context. This bolsters the idea of the climate forecasting system as being a distributed decision support system, rather than simply a one-way flow if information. It also points out the potential for the systems used to communicate forecasts having a great many applications within sustainable development, in terms of general technology and knowledge transfer.

4.2 How research builds on previously funded HDGEC research

While this is the first direct grant support by the Principal Investigator, it builds on work that he conducted while a graduate student participant in the Global Environmental Assessment research project at Harvard University, which received funding from a variety of sources, including NOAA, NSF, and DoE. In the final year of that research, Dr. Patt conducted extensive fieldwork in Zimbabwe, and participated in the SARCOF meeting, as he began to explore the role of seasonal climate forecasting in developing country decision-making. In that work, he identified the differential use of forecasts by different groups, based partly on the means by which they received the information, and also by the decisions that they could make in response to the information. The present project grew out of that, with the following hypothesis: if one were to implement the better communication practices for the traditional underserved groups, they would find ways of overcoming their other constraints to the use of the information.

4.3 Contribution of project to other areas of study

4.3.1 Adaptation to long-term climate change

The lessons regarding behavioral responses, challenges and opportunities in the realm of seasonal climate forecasts can be extended to climate change predictions. This includes the advantages of participatory approaches to defining adaptation strategies, behavioral patterns affecting the use of knowledge, and ideas for integrating forecast communication in larger processes of regional development.

4.3.2 Natural hazards mitigation

Forecasts can help to mitigate the impacts of drought, when they are used both by food planners and by farmers. Our results show that it is possible to expect farmers to make different decisions to mitigate the effects of an anticipated drought, but that, at the same, the extent of mitigation is often quite small.

4.3.3 Institutional dimensions of global change

Research on boundary organizations has shown that institutions for knowledge communication have to be embedded within both the scientific and the user communities. Our behavioral experimental findings provide the first quantitative data showing this to occur at the individual

level, in terms of the effects of the known incentives facing communicators. Thus, we suggest that the boundary organization literature ought to play an important role in the design of institutions for knowledge transfer.

4.3.4 Developing tools for decision makers and end-users

We have no findings related to the development of specific decision-support tools.

4.3.5 Economic value of climate forecasts

There have been no studies documenting the economic value of forecasts among developing country subsistence farmers. We do not provide quantitative information on this either. However, we do document the use of the information to make different decisions, in successive years, and this could be used to infer that people made choices based on the information that they liked, which in turn implies that they received a benefit from the information.

4.3.6 Sustainability of vulnerable areas and/or people

Scientific information rarely reaches the most vulnerable. Given the predictability of climatic variables, it is indispensable to formulate policies that may improve people's ability to meet their present and future needs. We believe that the participatory approach developed in the context of this project can contribute to sustainable development in Zimbabwe and many other developing countries.

4.3.7 Matching scientific info with indigenous knowledge

Our workshops allocate a significant proportion of time to the presentation and discussion of traditional forecasting methods, side by side with the scientific predictions based on El Niño. In our experience, not only there is no necessary conflict between the two approaches, but also there are potential synergies to be exploited. For example, the fact that traditional forecasts are likely to fail in any given year is a great way to introduce the probabilistic nature of ENSO forecasting. The key to a successful coexistence of the two approaches is a demonstration of respect and legitimate interest in indigenous knowledge on the part of the scientists.

4.3.8 The role of public policy in the use of climatic information

Even though this project does not directly deal with public policy issues, the responses to our surveys clearly indicate that forecasts cannot be used to their full potential unless other, more stringent limiting factors that are outside the realm of climate prediction. These limiting factors cannot be influenced significantly by individual action (particularly among subsistence farmers), and therefore public policy has a major role to play in creating an enabling environment for incorporating rainfall forecasts in the food security landscape.

4.3.9 Socio-economic impacts of decadal climate variability

We have no finding relevant to this issue.

4.3.10 Other

Gender

In many of our decision-making experiments, women outperformed men regarding the best way to incorporate information in the decision process. However, social structures in rural Zimbabwe and elsewhere tend to leave to men most of the responsibility for making decisions. While it is probably too early to draw policy conclusions on this topic, it could be argued that one way to facilitate the incorporation of forecasts in faring decisions would be to encourage initiatives that promote gender equality in the region.

Communicating Uncertain Information

The inherently uncertain nature of climatic processes and the probabilistic nature of scientific predictions were very central features of our workshops in rural Zimbabwe. While this implies more time and more work, it is clear to us that an honest communication of the limitations of our knowledge is essential to generating trust among farmers. They are perfectly capable of learning and figuring out what is best for them with regards to forecast use.

5 Graphics

We do not have graphics representing the project approach or framework. Several graphics, and photographs, provide useful and interesting information. Most of these graphics are also available on the project website: http:/people.bu.edu/apatt/zimbabwe.html